Integrating mammalian specimen archives, long-term research initiatives, and natural resource conservation

Andrew G Hope
Kansas State University

Konza Prairie LTER Site
Photo: Barb Van Slyke

Multiple roads to effective mammalian conservation

- Broader perspective of conservation than focusing on single species of concern.
- Biodiversity and ecosystem conservation through archive and study of **common species**.
- Long-term research initiatives (e.g., NEON, LTER)
  - Offer an ideal platform for this!
  - Generally perform basic science or observational data collection
  - Generally **not** applied management and biodiversity conservation
  - Data for study of system-level pattern and process.
  - For mammals this generally means population/community ecology

Mission of NSF Long Term Ecological Research Network

- *"…to provide the scientific community, policy makers, and society with the knowledge and predictive understanding necessary to* ***conserve, protect, and manage the nation's ecosystems, their biodiversity, and the services they provide."***

- **I contend that it's not possible to effectively fulfill this mission without ongoing specimen collections.**

- **I also suggest that long term specimen series would provide the resources to help resolve and mitigate the *causes* of continuing biodiversity declines.**

Goals of NSF Long Term Ecological Research Network

- Understanding
- Synthesis
- Outreach
- Education
- Information

- **Legacies:** To create a legacy of ***well-designed and documented*** long-term observations, experiments, and ***archives of samples and specimens for future generations.***

NATIONAL SCIENCE FOUNDATION
LTER NETWORK
LONG TERM ECOLOGICAL RESEARCH

National Ecological Observatory Network (NEON)

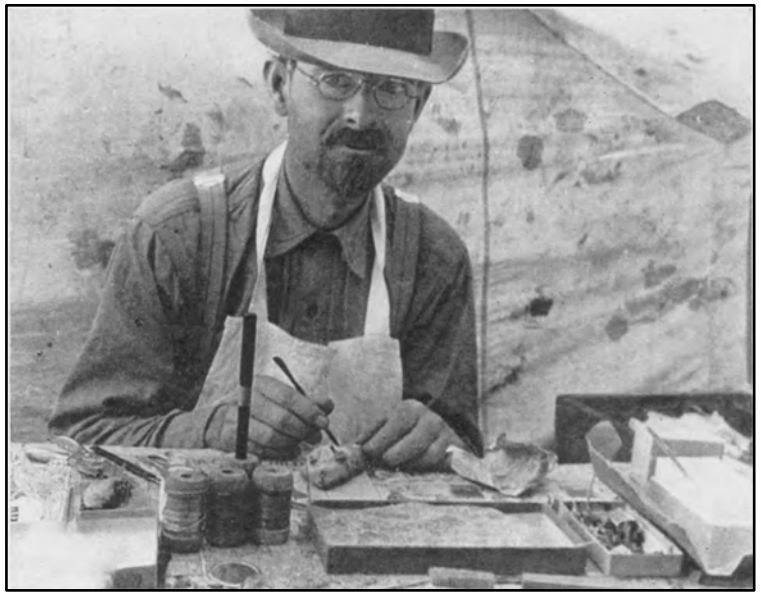
- Archives include targeted collection of whole vouchers from:
  - ***Aquatic macrophytes***
  - ***Mosses/lichens/liverworts***
  - ***Macroinvertebrates (including mosquitos and ticks)***
  - ***Plants***
  - ***Soil***
  - ***Microbes***

- **So, why not any vertebrates, given that active repositories exist?**

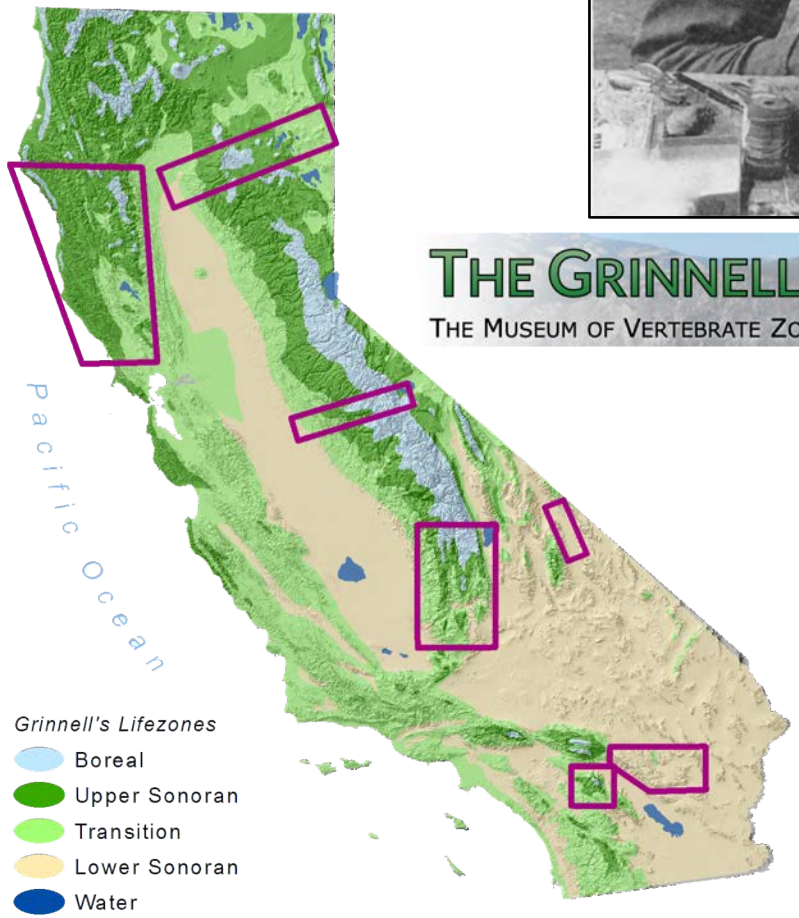
- **Mammal sampling includes ear punches, blood, faeces, fur, incidental mortalities.**
  - **Is this enough?**

First main focus – Time Series

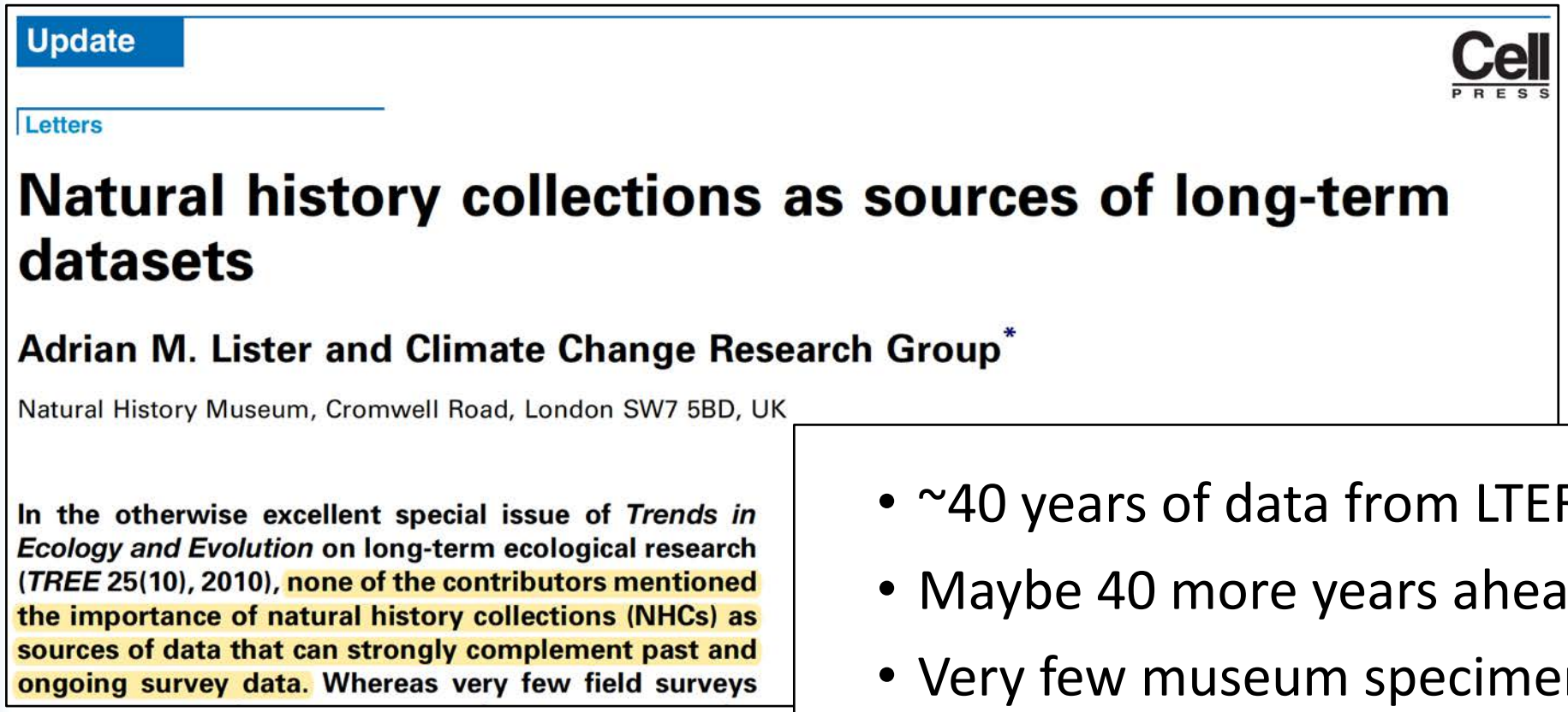
- This is a familiar concept
- Value of repeated specimen baselines is clear
- But, how often is enough?
  - Needs to be frequent enough to resolve rates and trajectories of change.
  - Is 100 years often enough?
  - The Great Acceleration began in 1960's…



THE GRINNELL RESURVEY PROJECT
THE MUSEUM OF VERTEBRATE ZOOLOGY, UC BERKELEY



Time Series and Long-term Research Initiatives



Update

Cell PRESS

Letters

Natural history collections as sources of long-term datasets

Adrian M. Lister and Climate Change Research Group*

Natural History Museum, Cromwell Road, London SW7 5BD, UK

In the otherwise excellent special issue of *Trends in Ecology and Evolution* on long-term ecological research (*TREE* 25(10), 2010), none of the contributors mentioned the importance of natural history collections (NHCs) as sources of data that can strongly complement past and ongoing survey data. Whereas very few field surveys

(Lister et al. 2011; *TREE*)

- ~40 years of data from LTER Network
- Maybe 40 more years ahead?
- Very few museum specimens from these sites

- Hind-sight 20/20…
- Telling the future?

Second main focus – Interdependent Biodiversity

esa

ECOSPHERE

DISEASE ECOLOGY: INNOVATIVE VIEWPOINTS

To improve ecological understanding, collect infection data

Alyssa-Lois M. Gehman[1,2,3,†], Dara A. Satterfield[1,4], Carolyn L. Keogh[1,5], Alexa Fritzsche McKay[1], and Sarah A. Budischak[1,6,7,8]

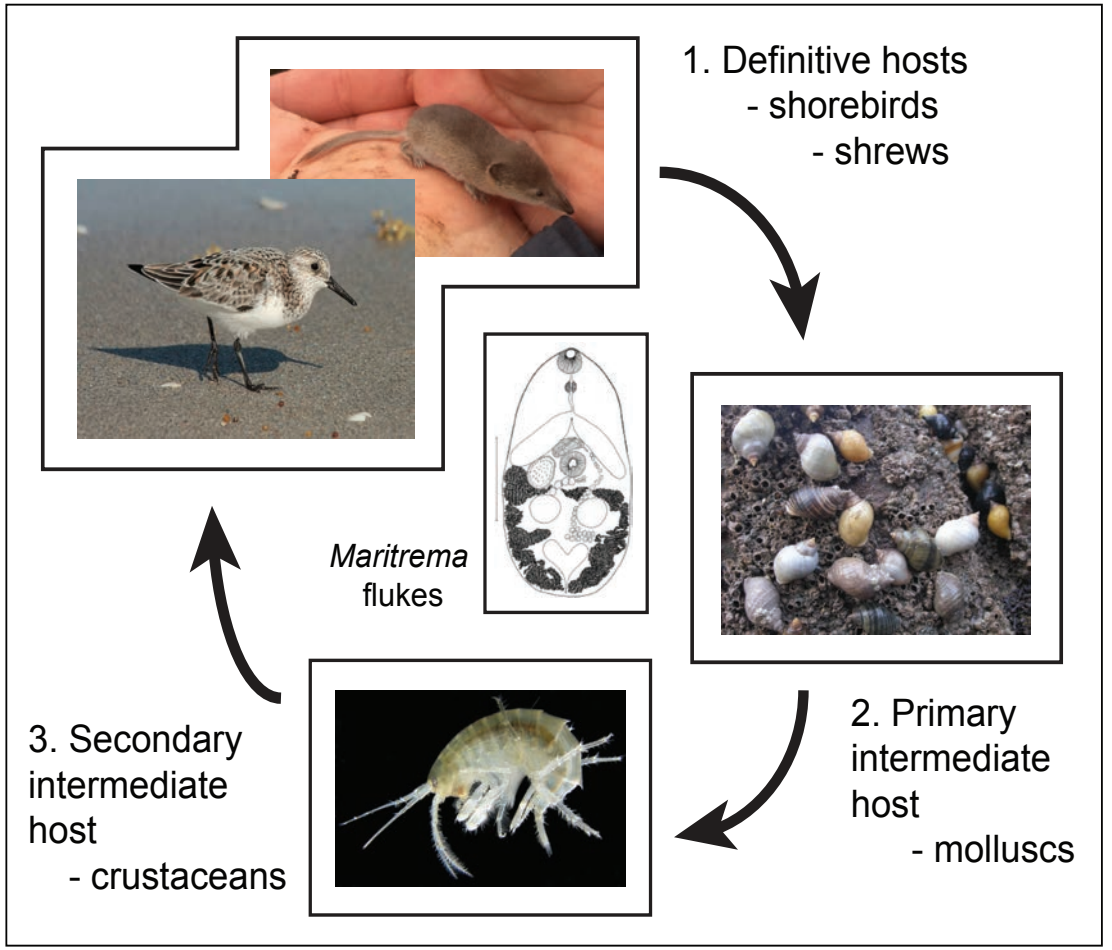
[1]*Odum School of Ecology, University of Georgia, Athens, Georgia, USA*
[2]*Hakai Institute, End of Kwakshua Channel, Calvert Island, British Columbia, Canada*
[3]*Department of Zoology, University of British Columbia, Vancouver, British Columbia, Canada*
[4]*Smithsonian Migratory Bird Center, Smithsonian Conservation Biology Institute, Washington, D.C., USA*
[5]*Department of Environmental Sciences, Emory University, Atlanta, Georgia, USA*
[6]*W. M. Keck Science Department of Claremont McKenna College, Claremont, California, USA*
[7]*W. M. Keck Science Department of Pitzer College, Claremont, California, USA*
[8]*W. M. Keck Science Department of Scripps College, Claremont, California, USA*

Citation: Gehman, A.-L. M., D. A. Satterfield, C. L. Keogh, A. F. McKay, and S. A. Budischak. 2019. To improve ecological understanding, collect infection data. Ecosphere 10(6):e02770. 10.1002/ecs2.2770

Mammals, parasites, other hosts are inter-connected

"…parasites are known to play major roles in the dynamics and persistence of populations as well as the structure and stability of communities and ecosystems…" (Gehman *et al.* 2019)

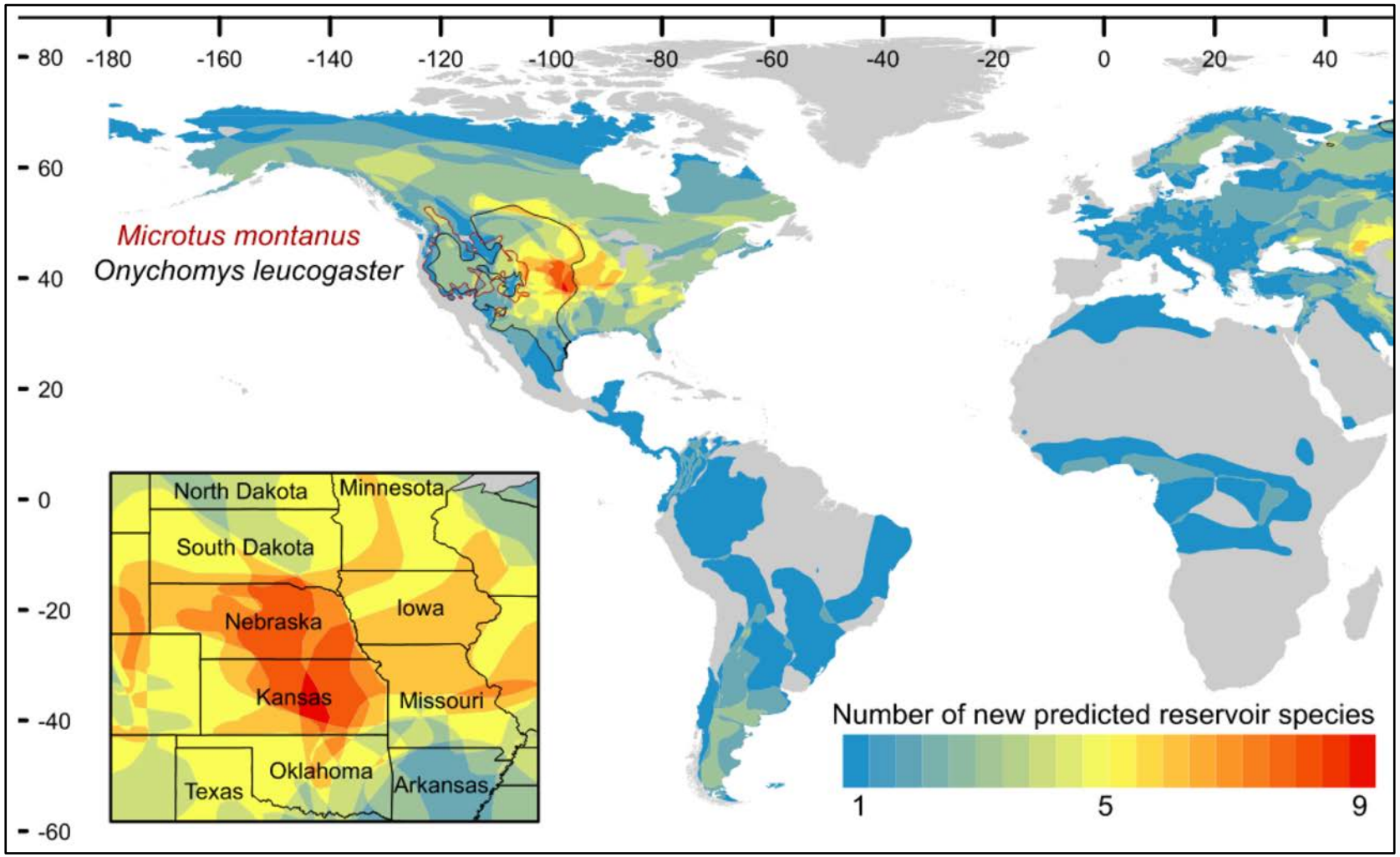
- Effective conservation requires a knowledge of existing biodiversity
  - Both describing species and understanding their complex ecologies
- Mammalian parasites are vastly underexplored
- **This is not possible without whole fresh host specimens**



(Hope *et al.* 2016)

Ecologists are mammals too!

- Field researchers are contracting zoonoses
- Public health is an increasing concern globally
- Likely related to biodiversity trends
- Still data deficient



"Rodent reservoirs of future zoonotic disease". Han et al. 2016; *PNAS*

Impact of specimen collecting

- This example applies to both common and locally rare species.

Forum

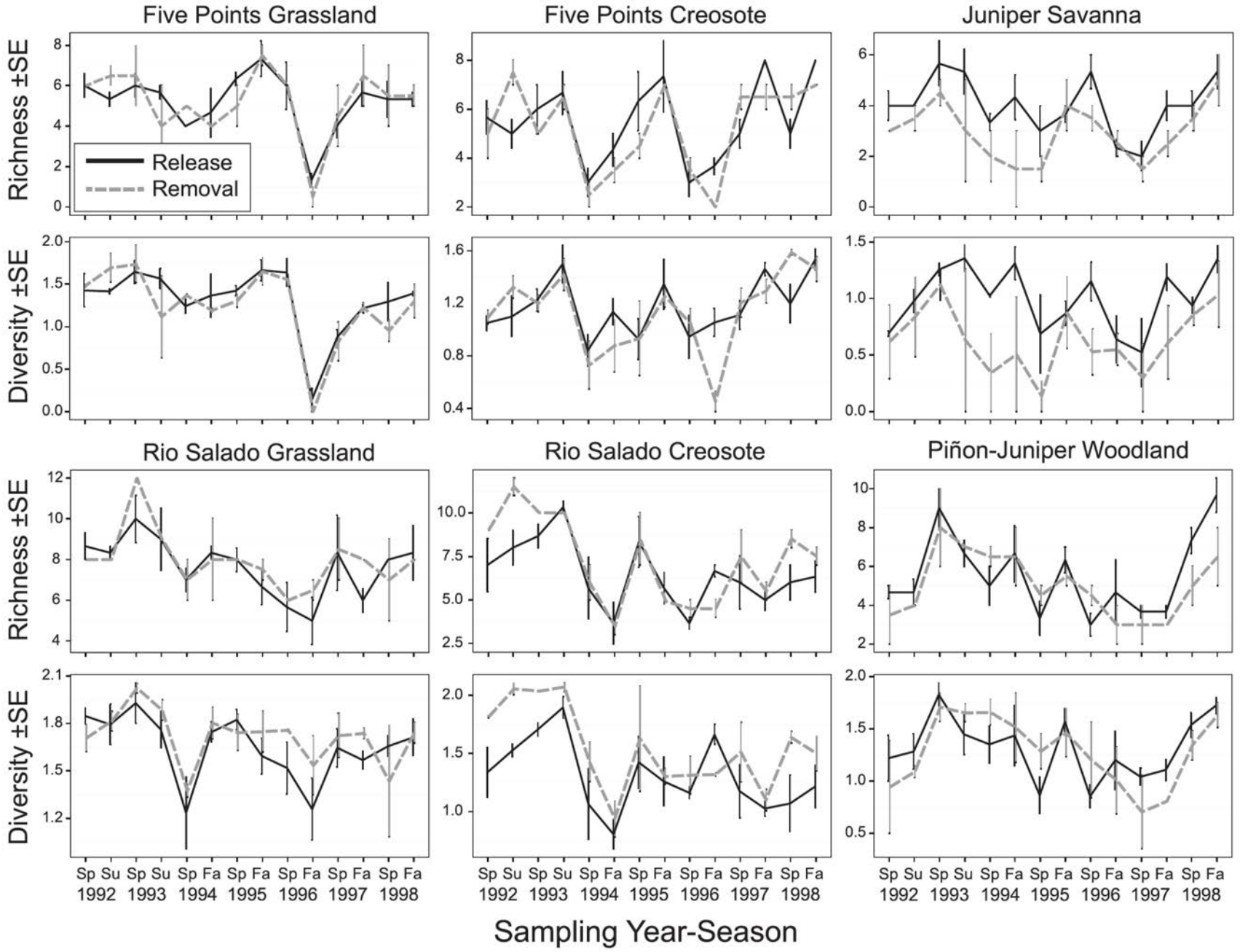
Collection of Scientific Specimens: Benefits for Biodiversity Sciences and Limited Impacts on Communities of Small Mammals

ANDREW G. HOPE, BRETT K. SANDERCOCK, AND JASON L. MALANEY

(Hope *et al.* 2018; *BioScience*)

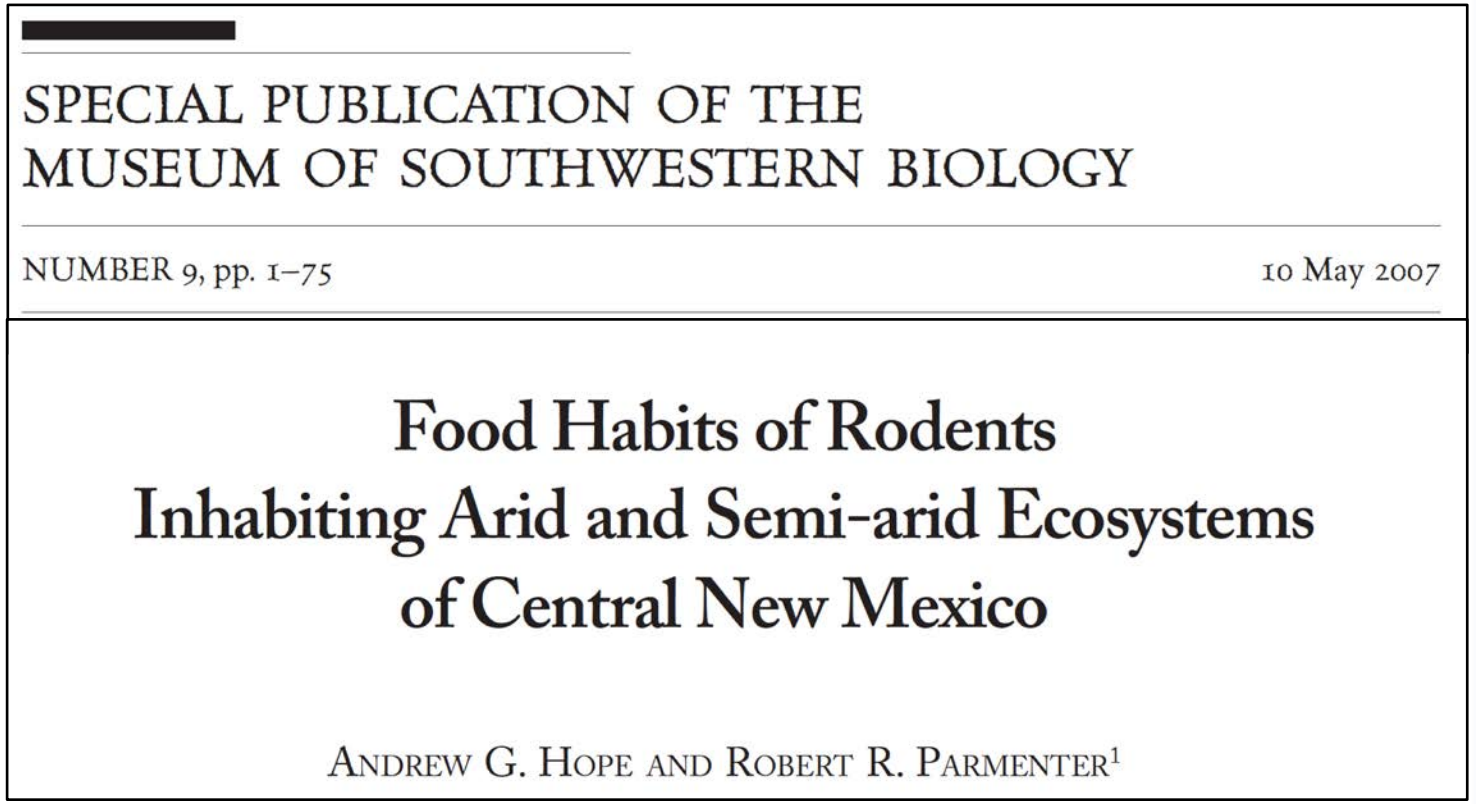
Sevilleta LTER New Mexico

- Multiple habitats
- 7 consecutive yrs
- No impact on:
  - Richness
  - Diversity
  - Abundance
- Traditional ecological data stream maintained
- Abundant vouchers for future research
- Parasite data!



Specimen-based long-term research

- Stomach content analysis
  - 625 specimens
  - 15 mammal species
- All specimens vouchered
- Same specimens now being used for stable isotope analysis 20 yrs later.



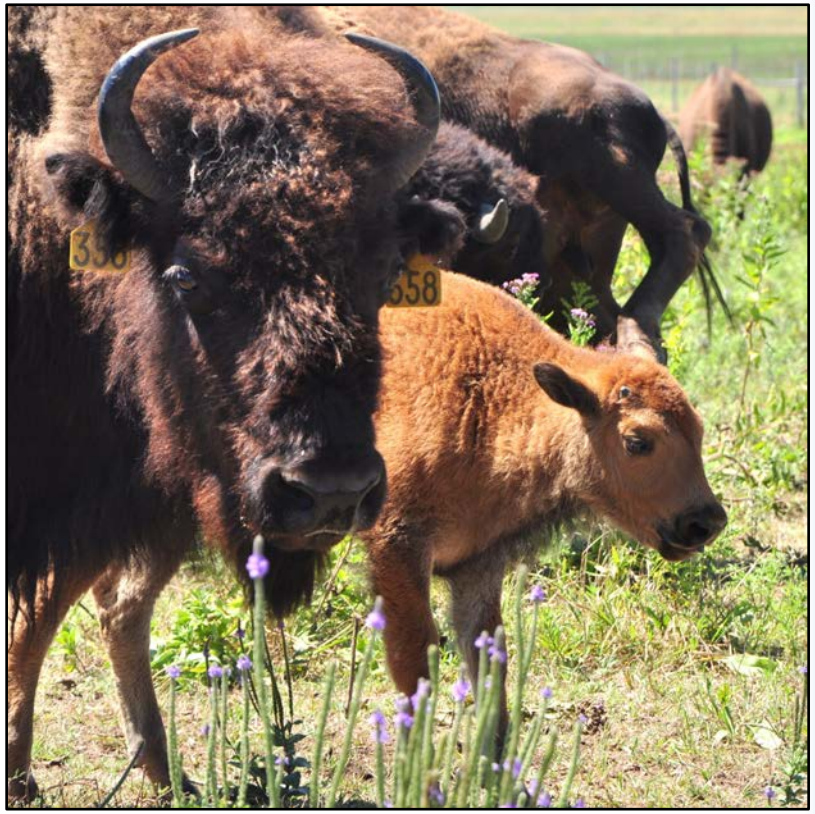
SPECIAL PUBLICATION OF THE
MUSEUM OF SOUTHWESTERN BIOLOGY

NUMBER 9, pp. 1–75 10 May 2007

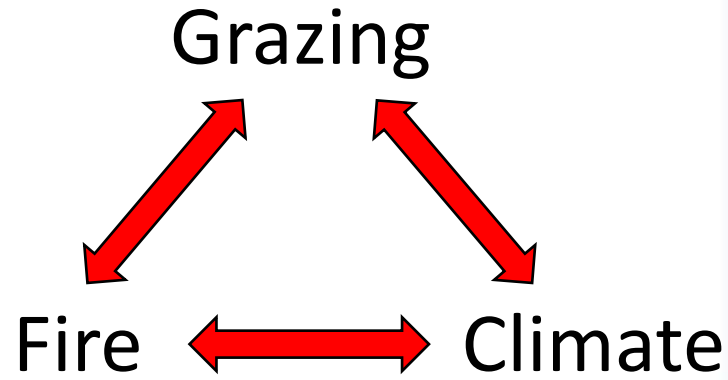
Food Habits of Rodents Inhabiting Arid and Semi-arid Ecosystems of Central New Mexico

ANDREW G. HOPE AND ROBERT R. PARMENTER[1]

Konza LTER, KS – Tallgrass Prairie



Drivers:



Small mammal sampling 2016-2019 – Konza LTER

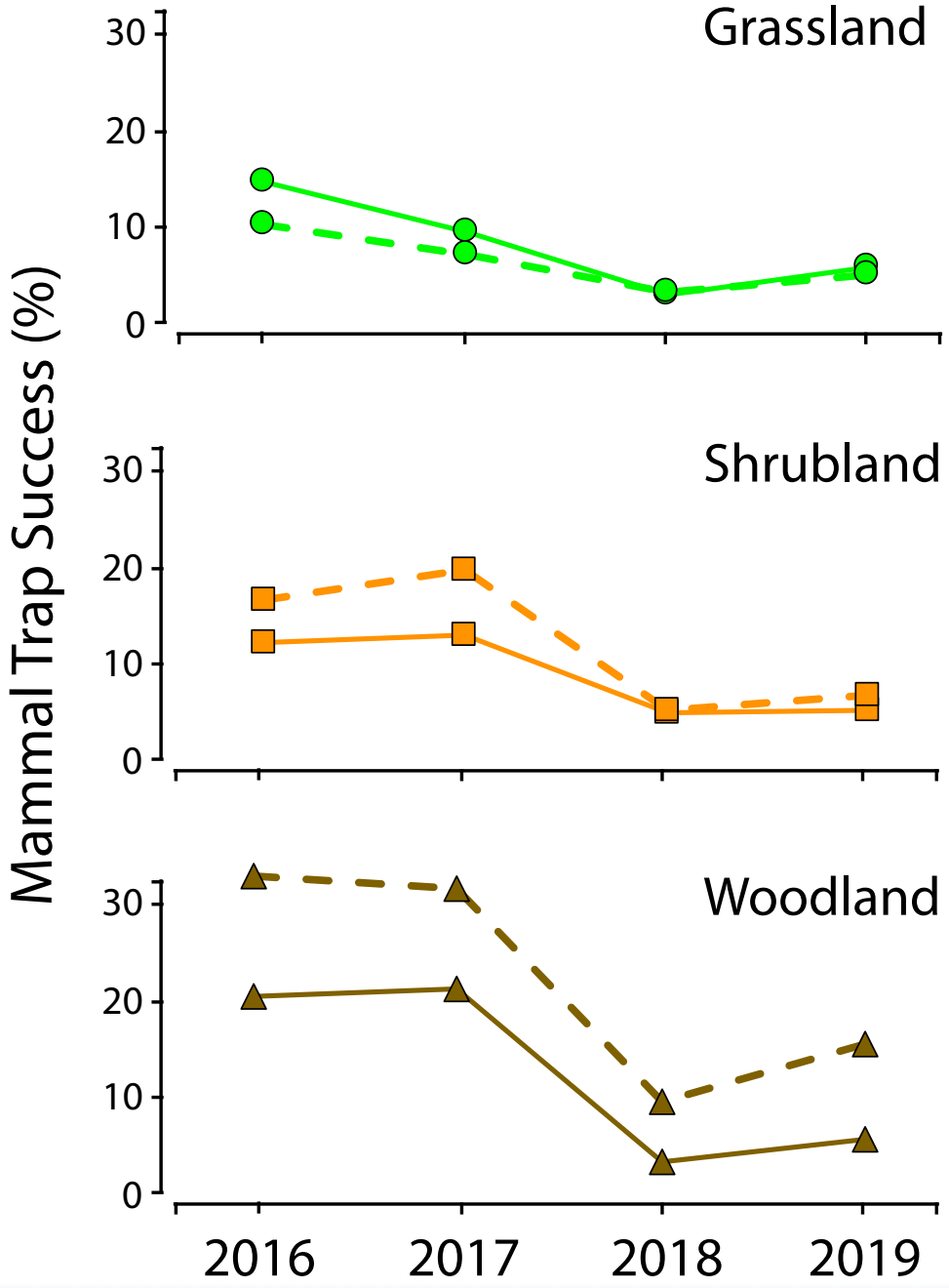
- 8 experimental burn treatments
- 2 transects per treatment
  - 1 Catch-and-release
  - 1 Specimen removal
- 160 trap nights per transect per year
- All specimens fully processed via published guidelines (Galbreath et al. 2019)
- Ecto-parasites
- Endo-parasites

Specimen data downloaded from Arctos database (arctos.database.museum)
Red = removal; Blue = catch-and-release

Impacts of specimen collecting in tallgrass prairie ecoregion

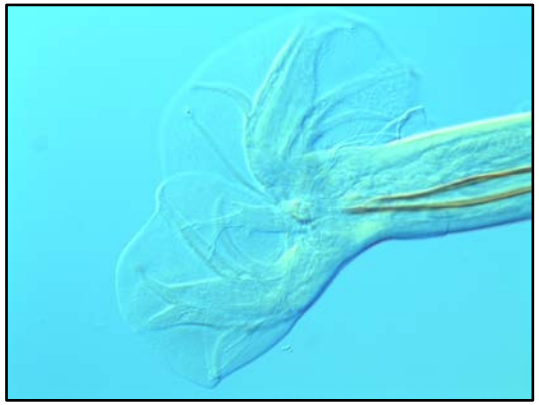
- No significant difference in trend lines
- Woody habitats support larger densities
- Populations strongly track precipitation

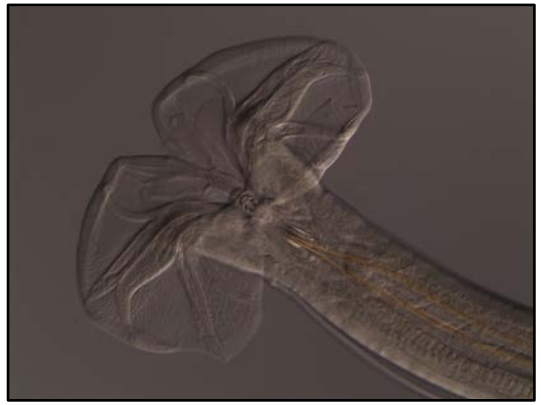
- Meacham *et al.* **poster #24**!



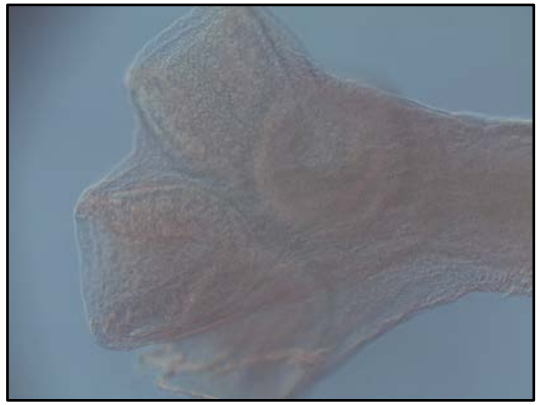
Endo-parasites (gut helminths)

- Many cestode and nematode species (3+ species per host specimen)
- Nematode *Vexillata armandae* – first described from **Sevilleta LTER**
- New nematode species (Genus: *Syphacia*) from *Peromyscus*
- New cestode species (Genus: *Hemenolepis*) from *Microtus ochrogaster*
- *Blarina hylophaga* parasites add to continent-wide sampling transect.





Vexillata armandae

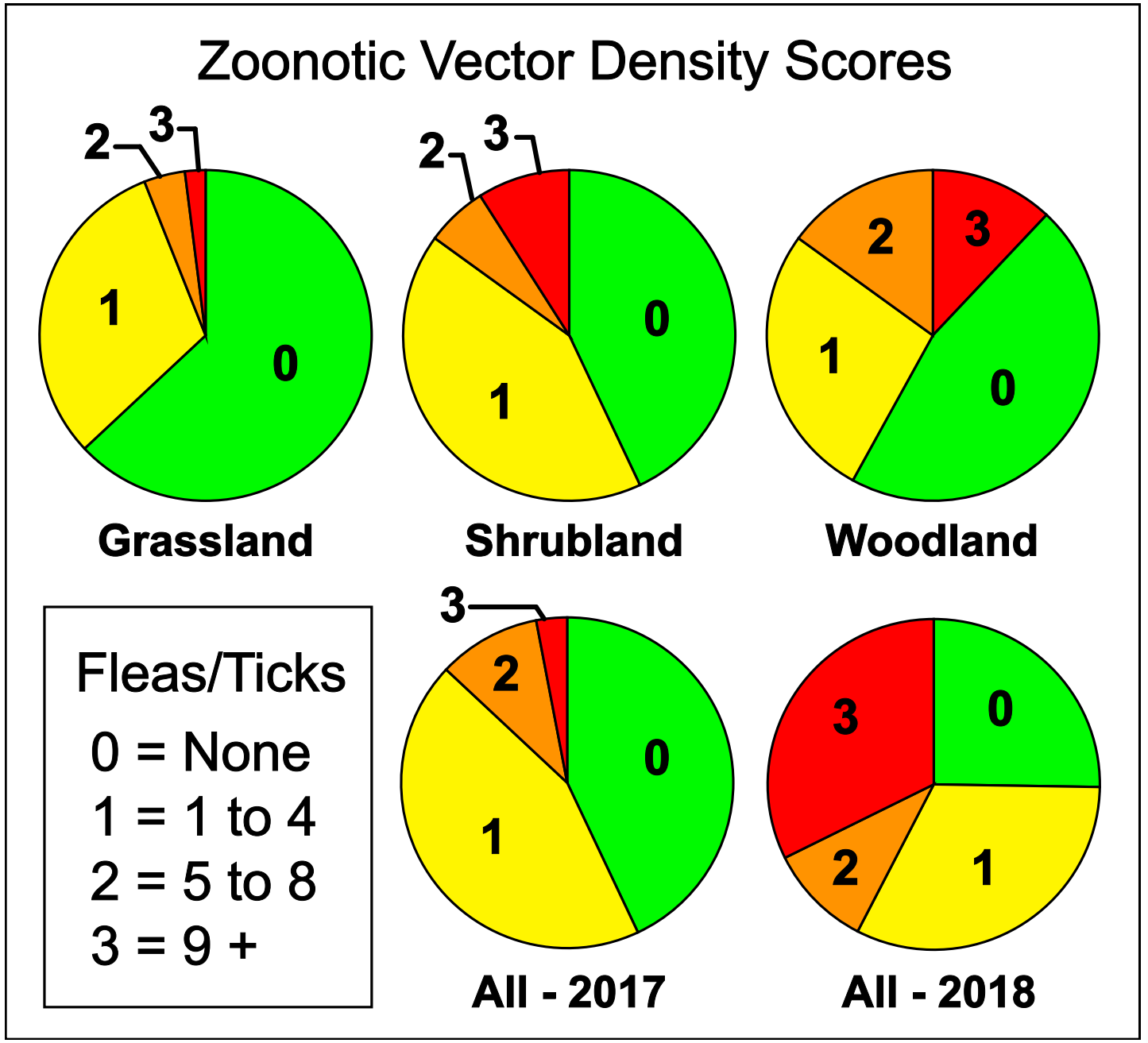


Hymenolepis spp.

Ecto-parasites (fleas, ticks, lice)

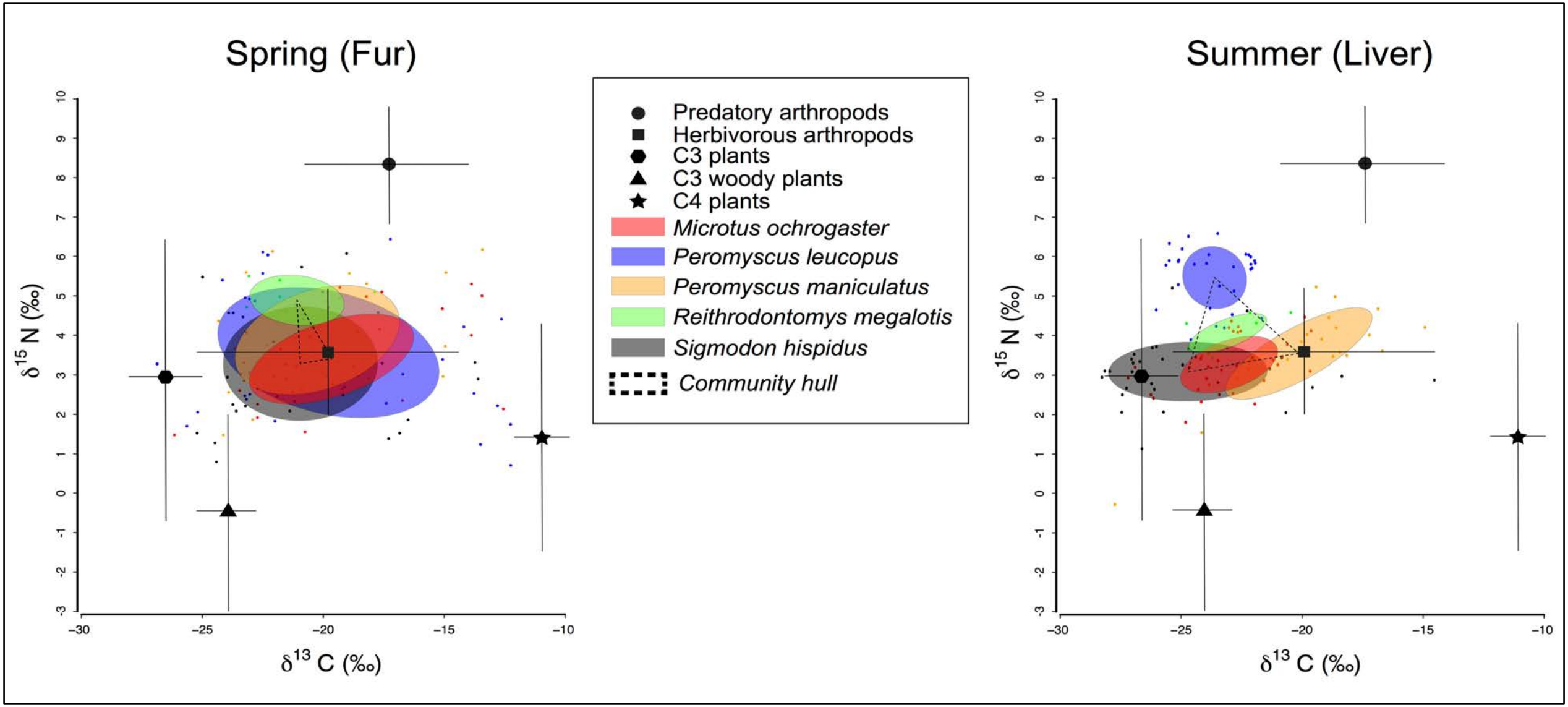
- Vectors of zoonotic disease are more prevalent in woody habitats
- Maintaining native prairie offers ecosystem services for human health.

- Meacham *et al.* **poster #24**!

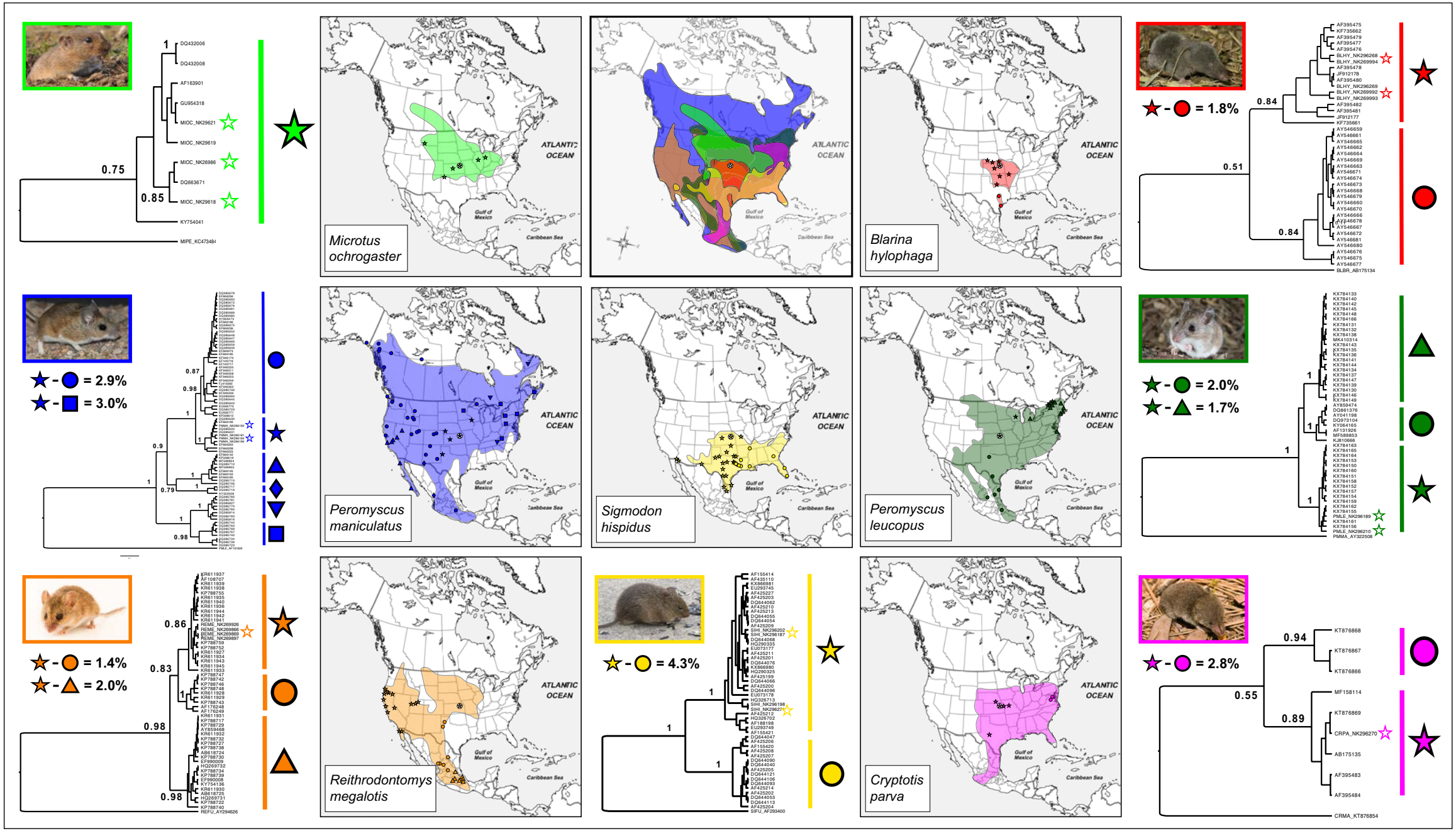


Small mammals as consumers

- Non-lethal sampling of fur provides only low resolution of dietary niche
- Multiple tissues from vouchered specimens greatly improve dietary reconstruction.



Phylogeography – tissue samples for genetics resolve community assembly



Schmidt *et al.* **poster #25**

Education – Inspiring mammalogists to integrate across biodiversity sciences

- Proceedings from 2018 ASM workshop
- Built upon decades of international collaboration
- Comprehensive resources for ecosystem conservation

Journal of Mammalogy, 100(2):382–393, 2019
DOI:10.1093/jmammal/gyz048
Published online 10 April 2019

Building an integrated infrastructure for exploring biodiversity: field collections and archives of mammals and parasites

Kurt E. Galbreath,* Eric P. Hoberg, Joseph A. Cook, Blas Armién, Kayce C. Bell, Mariel L. Campbell, Jonathan L. Dunnum, Altangerel T. Dursahinhan, Ralph P. Eckerlin, Scott L. Gardner, Stephen E. Greiman, Heikki Henttonen, F. Agustín Jiménez, Anson V. A. Koehler, Batsaikhan Nyamsuren, Vasyl V. Tkach, Fernando Torres-Pérez, Albina Tsvetkova, and Andrew G. Hope

Summary

- Benefits of voucher collections from long-term ecological research
  - Fine-scale time-series of archived mammalian resources
  - Preserved associated biodiversity (ecto- and endo-parasites)
  - Species discovery and description
  - Disease ecology and pathogen testing
  - Trophic ecology – mammals as consumers
  - Evolutionary history, lineage assignments, and community assembly
  - Disturbance ecology (impacts of specimen collecting)
  - Education of the value of specimen archives for ecological research
- Conserving "…*ecosystems, biodiversity, and the services they provide.*"

NATIONAL SCIENCE FOUNDATION
LTER NETWORK
LONG TERM ECOLOGICAL RESEARCH

2019

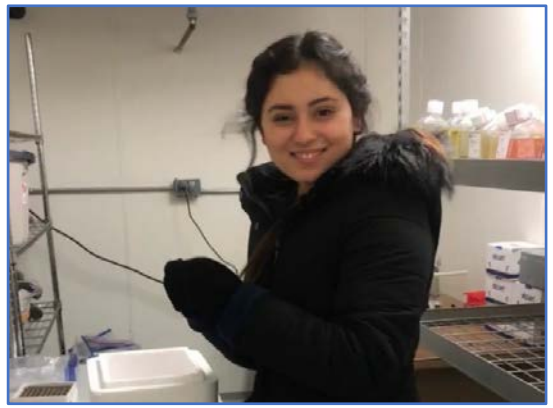
2018

2017

2016

Bia Gragg – stable isotopes

Kailey Meacham – Ecto's



Mary Schmidt
Mammal lineages

Museum of Southwestern Biology Division of Mammals

NSF

Konza Prairie Biological Station

LTER Network

Kansas State University

Colleagues in Prairie Conservation:

Dr. Fraser Combe (KSU)

Dr. Agustin Jimenez-Ruiz (SIU)

Dr. Vasyl Tkach (UND)

Thanks!

Contact me: ahope@ksu.edu